Research Article

European Addiction Research

Eur Addict Res
DOI: 10.1159/000500520

Received: October 7, 2018
Accepted: April 18, 2019
Published online: May 21, 2019

How Are Self-Efficacy and Motivation Related to Drinking Five Years after Residential Treatment? A Longitudinal Multicenter Study

Anja Müller[a] Hansjörg Znoj[b] Franz Moggi[a]

[a]University Hospital of Psychiatry and Psychotherapy, University of Bern, Bern, Switzerland; [b]Institute of Psychology, Department of Clinical Psychology and Psychotherapy, University of Bern, Bern, Switzerland

Keywords

Abstinence-related self-efficacy · Action-oriented motivation · Mediation analyses · Alcohol use disorder · Long-term drinking outcome

Abstract

Background: Abstinence-related self-efficacy and action-oriented motivation to change addictive behaviours have been demonstrated to be important predictors of post-treatment drinking. However, there are only a few studies that assess drinking outcomes through a long-term follow-up interval. ***Objectives:*** The purpose of this longitudinal observational study is to evaluate whether self-efficacy and motivation at a 1-year follow-up mediate the relationship of self-efficacy at discharge from residential treatment with drinking outcomes at 5-year follow-up. ***Method:*** Simple and serial multiple mediation analyses were conducted on data collected from 263 patients (174 men, 89 women) with severe alcohol use disorder (AUD). Self-efficacy was measured at discharge and 1-year follow-up, and motivation was also measured at 1-year follow-up. Abstinence, percent days of abstinence (PDA), and drinks per drinking day (DDD) were used as drinking outcomes at 5-year follow-up. Exploring the indirect paths provided details about the interrelationship between self-efficacy and motivation. ***Results:*** Self-efficacy at discharge predicted abstinence and PDA. The mediation models suggest that self-efficacy at discharge was associated with self-efficacy and motivation at 1-year follow-up, which in turn was related to better long-term drinking outcomes, in particular for abstinence and PDA at 5-year follow-up. No such effects were found for DDD. ***Conclusions:*** The results indicate that self-efficacy and motivation are interrelated in improving long-term abstinence and PDA following residential treatments and may play a substantial role in recovery from AUD.

Introduction

Alcohol use disorder (AUD) is a major health problem that has serious biological, psychological and social consequences as well as immense direct and indirect costs [1]. Many studies have explored the predictors of drinking outcomes following residential treatment for AUD, such as patient characteristics, in a search for malleable predictors to identify target areas for treatment. The most consistent patient predictors, according to the comprehensive review of Adamson et al. [2], are severity of alcohol

KARGER

E-Mail karger@karger.com
www.karger.com/ear

Franz Moggi
University Hospital of Psychiatry and Psychotherapy
University of Bern
Bolligenstrasse 111, CH–3000 Bern 60 (Switzerland)
E-Mail franz.moggi@upd.unibe.ch

dependence, psychopathology, treatment goal, abstinence-related self-efficacy and motivation to change drinking behaviour. In the present longitudinal study, we evaluate whether self-efficacy and motivation at 1-year follow-up mediate the relationship of self-efficacy at discharge from residential treatment with drinking outcomes at 5-year follow-up.

Self-efficacy plays a key role in Social Cognitive Theory [3, 4], and particularly in health behaviour change models of substance use disorders (SUDs), such as the transtheoretical model of change (TTM; [5]) or the relapse prevention model [6]. Self-efficacy refers to the patients' confidence in their own ability to minimize or stop their alcohol consumption, resist craving and temptation and maintain behavioural changes in drinking over time. Studies have revealed that abstinence-related self-efficacy is one of the most consistent predictors of post-treatment drinking frequency and/or quantity at 1-year follow-up [2, 7, 8], 2-year follow-up [9], 3-year follow-up [10] and even 16-year follow-up [11]. Maisto et al. [10] found that the relationship between 1- and 3-year post-treatment alcohol use outcomes was mediated by self-efficacy but not by social or psychological functioning at 15-month follow-up. Based on that finding, the authors suggest that improving self-efficacy within the first post-treatment year is crucial to the long-term maintenance of changes in alcohol use.

Earlier studies have measured patients' ability to refrain from alcohol consumption in specific high-risk situations using questionnaires, such as the Alcohol Abstinence Self-Efficacy Scale [12] and the Situational Confidence Questionnaire [13]. Hoeppner et al. [14] demonstrated that a single question (i.e., "How confident are you that you will be able to stay clean and sober in the next 90 days, or 3 months?") has proven to have good convergent and discriminant validity in measuring self-efficacy. In addition, this single-item measure has been found to be a strong predictor of relapse in substance use 1, 3 and 6 months post-discharge from treatment and has been revealed as superior to the adapted version of the Alcohol and Drug Abstinence Self-Efficacy Scale [14]. Moreover, high scores on a single item measure at discharge from residential treatment predicted alcohol abstinence at a 12-month follow-up [15, 16] and were associated with alcohol use and reduced AUD symptoms up to 5 years following AUD treatment [17].

In contrast, the survey of Demmel et al. [18] could not support the general predictive character of self-efficacy that was unrelated to both drinking quantity and frequency of 12 weeks after treatment. The authors assume that end-of-treatment self-efficacy or changes in self-efficacy during treatment might be stronger predictors of recovery from AUD.

A second crucial malleable patient predictor and main target in motivational enhancement therapies (e.g., motivational interviewing; [19]) is motivation to change [2], which plays an important role in recognizing the need for behavioural change, overcoming ambivalence, seeking treatment, successfully reducing alcohol consumption and sustaining behavioural change to recover from AUD [20]. The concept of motivation to change is described in the TTM proposed by Prochaska et al. [5], who grouped motivation into 5 stages of change to express different phases of motivation toward performing future behaviour.

The Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES) is one of the most commonly used questionnaires measuring a patient's motivation to change AUD related behaviour [21]. It contains 3 subscales, which are recognition, ambivalence and taking steps, whereby only the last subscale, which refers to the patient's actions to modify their problematic behaviour and maintain behavioural changes, has been frequently proven as a predictor of better drinking outcomes [22]. In several studies, higher scores on taking steps or action-oriented motivation predicted better alcohol use outcomes at 1-year follow-up [22–24].

There is limited research with mixed results about the interplay between abstinence-related self-efficacy and action-oriented motivation, two concepts that are theoretically but also empirically associated with advanced stages of change (i.e., action and maintenance stage of TTM), which in turn have positive effects on drinking outcomes [21, 25]. For instance, a longitudinal study on the number of drinking days during outpatient cognitive-behavioural treatment showed that high self-efficacy in patients who had already a high percentage change in drinking prior to treatment was associated with fewer drinking days during treatment. In contrast, low percentage change in drinking prior to treatment was related to more drinking days during treatment despite patients' high self-efficacy, supporting the maintaining change hypothesis of self-efficacy. No differences were found for low self-efficacy [26]. While Witkiewitz and Marlatt [6] also report that hesitation toward change is often related to low self-efficacy, findings from Kelly and Greene [27] showed that patients with low self-efficacy did not necessarily have poor drinking outcomes, especially if they had a strong recovery motivation.

In contrast, Miller and Rollnick [19] even argue that high self-efficacy is necessary for the beginning of behavioural change (i.e., initiating change hypothesis of self-efficacy). In a study using a daily ecological momentary

assessment, the process analysis on the influence of both self-efficacy and motivation on drinking behaviour during outpatient treatment showed that the higher the patients' confidence and commitment to reducing drinking had been, the lower was the actual amount of alcohol consumed the next day [28]. Models of self-efficacy [19] and motivation [29] suggest a complex interplay, which includes reciprocal relationships and indirect effects [6]. In order to improve the self-efficacy, patients most likely need to experience success in overcoming obstacles to change their patterns of alcohol consumption by taking steps towards behavioural change, suggesting that prolonged post-treatment abstinence is associated with an increase in self-efficacy [9, 10].

The present study aims to address the question of how confidence in remaining abstinent after residential treatment is related to long-term drinking outcomes. It was hypothesised that self-efficacy at discharge would significantly predict drinking outcomes at 5-year post-treatment follow-up and that particularly prolonged abstinence is related to an increase while drinking is associated with a decrease in self-efficacy. This longitudinal study expands on previous research regarding this relationship by analyzing the mediation through self-efficacy and motivation at 1-year follow-up both separately and together. Exploring the indirect paths provides details about the interrelation between self-efficacy and motivation. From a clinical perspective, this study also points to the potential relevance of the improvement of self-efficacy as one focus of residential treatment towards positive long-term drinking outcomes, as well as to the ways in which self-efficacy and motivation 1 year following residential treatment may contribute to these outcomes.

Materials and Methods

Procedure

This secondary analysis utilised data from a longitudinal naturalistic multicentre study in Switzerland [30, 31]. Patients from 12 selected standard-practice AUD residential treatment programs completed an intake information form at admission after detoxification, a discharge information form after completing treatment programs, a follow-up information form 1-year post-treatment and a 5-year follow-up information form 5-years post-treatment. A follow-up measurement 1 year after residential treatment is common in research because the behaviour with regard to drinking is usually stabilized up until then. A 5-year follow-up was selected as the second measurement time in order to investigate clinically relevant and to date rarely examined long-term outcomes. Questionnaires for the 1- and 5-year follow-ups were sent by mail. The Ethics Committee of the Canton of Bern, Switzerland, approved the original study (Proposal-Nr: 109/99).

Patients

A total of 1,088 patients with SUD were invited to participate in this study. Of those who agreed to participate, 772 gave written informed consent and completed the questionnaire at admission, 647 (83%) completed the questionnaire at discharge and 573 (74%) at 1-year follow-up. Between the study onset and the 5-year follow-up inquiry, 97 (12.5%) patients died, 230 (30%) did not answer, 62 (8%) could not be located for the 5-year follow-up and 97 (12.5%) refused further participation. Of the 286 (37%) patients who provided data at admission, discharge, 1-year, as well as 5-year follow-up, 263 (92%) had an AUD without concurrent use of other drugs and were included in the present study. Comparisons were drawn between patients who completed the entire study and those who dropped out before having completed the 5-year follow-up assessment; these comparisons were related to demographic and clinical variables at admission, alcohol use during treatment and self-efficacy at discharge. Group comparisons revealed merely 2 differences: Individuals who completed the study were more often married (29 vs. 40%; χ^2 [1] = 7.62, p = 0.006, Cramer's V = 0.105) and employed (48 vs. 59%; χ^2 [1] = 7.66, p = 0.006, Cramer's V = 0.105) at admission compared to those in the dropout group.

Residential AUD Treatment Programs

The 12 selected standard-practice AUD residential treatment programs were abstinence-oriented and had typical characteristics of the German-speaking part of Switzerland. Patients received support from psychologists, psychiatrists, nurses and social workers during the treatment process. Characteristics of AUD treatment programs have been extensively described and compared to U.S. programs in previous studies [30, 31].

Measures

Questionnaires included questions about demographic information, psychological and social functioning, as well as substance use and its consequences. *Sociodemographic information,* such as age, gender, marital status, educational background and employment status, were collected with the intake information form at admission. *Severity of alcohol dependence* was assessed by 9 items drawn from the Alcohol Dependence Scale [32] with a total score ranging from 0 to 36 (Cronbach's α = 0.92). *Substance use problems* were assessed with 15 items [32], with scores ranging from 0 to 60 (Cronbach's α = 0.80). *Psychiatric symptoms* were collected with the Brief Symptom Inventory, using the subscales Depression, Anxiety, Paranoid Ideation and Psychoticism [33]. There were a total of 22 items with scores ranging from 0 to 88 (Cronbach's α = 0.93). *Abstinence during treatment* was assessed with 1 question: "Have you had alcohol since entering this treatment program?" and was coded as 1 for abstinent and 0 for not abstinent.

To measure *abstinence-related self-efficacy*, patients were asked to rate the following single question on a scale ranging from 1 (*not confident at all*) to 10 (*extremely confident*): "How confident are you that you will be completely abstinent in 1 year?" *Action-oriented motivation to change behaviour* was measured using the 8 items of the taking steps subscale of the SOCRATES [21]. Items were assessed on a 5-point Likert scale ranging from "*strongly disagree*" (0) to "*strongly agree*" (4). Scores ranged from 0 to 24 (Cronbach's α = 0.80). At treatment discharge, the former construct of interest – motivation to change – was not measured as it was at admission because *maintaining* the achieved change became the focus.

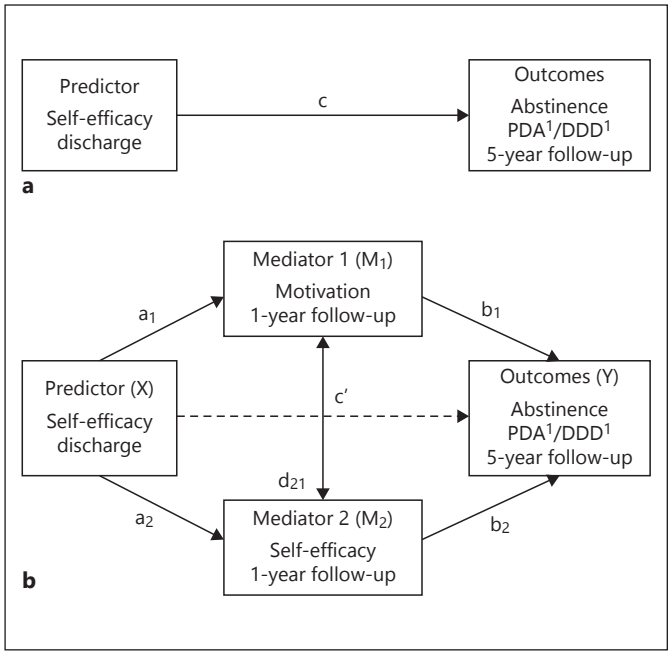

Fig. 1. Structural representation of the multiple serial mediation model and its 3 indirect effects. **a** Total pathway. **b** Indirect pathway (a_1b_1; $a_2d_{21}b_2$; a_2b_2 = indirect effects). [1] Drinking group. PDA, percent days of abstinence; DDD, drinks per drinking day.

Three drinking outcomes were assessed: *Abstinence* as a dichotomous variable of yes or no, defined as no alcohol consumption throughout the 3 months preceding the completion of the 5-year follow-up information form (coded as 1 = abstinent, and 0 = not abstinent). Two outcomes were defined for patients who were drinking at 5-year follow-up. Drinking frequency, compiled by percent days of abstinence (PDA), was assessed with the question "On how many days did you drink alcohol in the past 3 months?" The score was calculated by dividing the number of days on which no drinking occurred by the number of days in the period for which data are available. Drinking quantity was measured as drinks per drinking day (DDD) asking the question: "In the last 3 months, how many drinks did you normally drink on those days when you drank alcohol?" One drink was defined as a standard drink of 10 g ethanol.

Statistical Analyses

All statistical analyses were computed using SPSS 25.0. First, demographic, clinical variables at admission to the treatment, mediators and outcomes were computed and correlated. Second, the assumptions for the methods and analyses were investigated. Third, Chi-square (χ^2) tests for dichotomous variables; *t* tests and Mann-Whitney U test for continuous variables were performed to compare group differences (dropouts vs. completers) and an analysis of variance for repeated measures with self-efficacy at all 4 measurements was calculated to compare the abstinent with the drinking group.

Hypotheses were tested using the PROCESS procedure for SPSS version 2.16.3 by Hayes [34], with 1,000 bootstrap resamplings. Simple mediation analyses were conducted with model number 4 of the PROCESS procedure. For these analyses, we used the variables *motivation* as a mediator for the first model, and *self-efficacy* at 1-year follow-up for the second model. Both models were tested for the outcome variables at 5-year follow-up. The procedure allowed us to consider the effect of the predictor on the mediator (the "a path"), the effect of the mediator on the outcome (the "b path") and the effect of the predictor on the outcome through its effect on the mediator (the "c' path"). Additionally, the total effect of the predictor on the outcome was labelled as the 'c path'. Subsequently, serial multiple mediation analyses were conducted with model number 6 in PROCESS. The existence of multiple indirect paths implies that the predictor influences the outcome via multiple pathways. Figure 1 shows the serial multiple mediation model and its 3 indirect pathways.

Mediation analyses were conducted for the dichotomous outcome variable abstinence in the total sample using logistic regression, while PDA and DDD were only performed for patients who continued drinking at 5-year follow-up (drinking group). Furthermore, a heteroscedasticity-consistent standard error estimator, known as HC3, was used in the mediation analyses provided by PROCESS. The indirect effects are considered significant if the 95% bias-corrected bootstrapped confidence intervals (95% BCa CI) do not contain zero. A significant level of alpha 0.05 was used for all statistical tests.

Covariates

Covariates were not illustrated in all structural representations for reasons of convenience and a better overview of the pathways. Four covariates were included in the mediation analyses with the outcome variable abstinence: gender, marital status, employment and abstinence during treatment. The last item was excluded in the mediation analyses with the outcomes, PDA and DDD. All covariates controlled for the effects on the mediation and outcome variables. Gender was included due to findings showing that gender differences were related to self-efficacy and drinking outcomes [35] and to motivation to change [24, 36]. Marital status and employment were found to be different between those who were followed successfully until 5-year post-treatment and those who dropped out of the study. Finally, abstinence during treatment was included in the models with abstinence as an outcome, since Farren et al. [37] and Ludwig et al. [16] had found it to predict future abstinence. Although AUD severity and psychiatric symptoms have been identified as predictors of treatment outcome in the literature [2], they are not included in the analyses as covariates because they did not correlate significantly with outcomes or mediators in our study (rs ranges from –0.11 to 0.12).

Results

Demographic and Clinical Characteristics of the Sample

Table 1 represents sociodemographic and clinical characteristics at admission as well as variables of interest for the total sample, which consisted of both the abstinent and drinking groups at 1- and 5-year follow-up.

Table 1. Variables at admission, discharge, 1-year, and 5-year follow-up for the total sample, the abstinent group and the drinking group

	Total sample		Abstinent group		Drinking group	
	N[a]	%/mean (SD)	*n*[a]	%/mean (SD)	*n*[a]	%/mean (SD)
Variables at admission						
Age, years	263	45.6 (9.00)	141	45.74 (9.38)	122	45.4 (8.57)
Gender						
Male	174	66	83	59	91	75
Female	89	34	58	41	31	25
Marital status						
Married	103	40	61	43	78	65
Others	157	60	79	56	42	35
Education						
Less than high school	33	13	22	16	22	9
High school	23	9	10	7	13	11
High school + 2 years	182	170	93	67	89	74
College	21	8	14	10	7	6
Employed						
Yes	154	59	83	59	71	59
No	106	41	57	41	49	41
Psychiatric symptoms	260	1.07 (0.65)	140	1.13 (0.67)	120	1.01 (0.61)
Alcohol dependence	259	19.11 (10.41)	140	20.06 (9.99)	119	18.00 (10.81)
Substance use problems	260	15.10 (9.30)	140	15.35 (9.91)	120	14.80 (8.57)
Self-efficacy	257	7.89 (1.67)	137	8.16 (1.53)	120	7.59 (1.77)
Variables at discharge						
Self-efficacy	246	7.88 (1.91)	134	8.21 (1.64)	112	7.50 (2.12)
Abstinence	177	72	103	77	74	65
Variables at 1-year follow-up						
Motivation	233	24.99 (6.02)	125	25.94 (5.74)	108	23.90 (6.18)
Self-efficacy	242	7.03 (2.80)	132	7.76 (2.51)	110	6.15 (2.90)
Abstinence	115	48	79	60	36	33
Variables at 5-year follow-up						
Motivation	238	23.10 (6.14)	121	25.56 (5.54)	117	20.56 (5.69)
Self-efficacy	259	6.90 (3.06)	140	8.59 (2.10)	119	4.92 (2.81)
Abstinence	141	54	141	100	–	–
PDA	263	0.78 (33.05)	125	1.00 (0)	122	0.56 (0.35)
DDD	263	4.51 (7.19)	141	25.94 (5.74)	122	9.76 (7.79)

[a] Variation in sample size is due to missing data.
PDA, percent days of abstinence; DDD, drinks per drinking day.

We drew comparisons between patients with and without missing data on all demographic and outcome variables. In total, 49 patients had 1 or more missing value. Patients without missing values were more likely to be married, 24 vs. 43%; χ^2 (1) = 5.76, p = 0.020, Cramer's V = 0.149. No other differences were found.

Correlation between Predictor and Mediator

Correlation analyses demonstrated weak to moderate correlations between predictors and mediators in the total sample as well as in the drinking group. In the total sample, self-efficacy at discharge showed a moderate association with motivation at 1-year follow-up, r = 0.492, $p < 0.001$ and with self-efficacy at 1-year follow-up, r = 0.546, $p < 0.001$. In the drinking group, self-efficacy at discharge showed a moderate association with motivation at 1-year follow-up, r = 0.526, $p < 0.001$ and with self-efficacy at 1-year follow-up, r = 0.628, $p < 0.01$.

The variance inflation factors (VIF) and the tolerance values were acceptable. VIF varied from 1.025 to 1.724 in the total sample and from 1.029 to 2.014 in the drinking

Table 2. Logistic regression and regression model summary for simple mediation analysis of self-efficacy at discharge on abstinence and PDA at the 5-year follow-up

Outcome variable	Mediator	A path			B path			C path			Indirect effect			
		b	*SE*	*t*	*b*	*SE*	*t/z*	*b*	*SE*	*t/z*	*b*	boot *SE*	*z*	95% boot CI
Abstinence[1]	Motivation[a]	1.562	0.247	6.323***	0.020	0.028	0.738	0.451	0.095	1.530	0.032	0.049	0.724	–0.041 to 0.331
	Self-efficacy[b]	0.796	0.075	10.582***	0.209	0.062	3.378***	0.039	0.099	0.400	0.167	0.058	3.205**	0.066 to 0.284
PDA	Motivation[c]	1.807	0.301	5.994***	0.022	0.007	3.008**	–0.005	0.022	–0.224	0.039	0.014	2.659**	0.016 to 0.071
	Self-efficacy[d]	0.689	0.087	7.883***	0.053	0.014	3.805***	–0.005	0.021	–0.239	0.037	0.011	3.404***	0.016 to 0.061

Regression models are adjusted for the covariates gender, marital status, employment and abstinence during treatment (only with outcome variable abstinence); A path = path from independent variable to mediator variable at the 1-year follow-up; B path = path from mediator variable to outcome variable; C' path = path from independent variable to outcome variable; b = unstandardized regression coefficient.

[1] Logistic regression was calculated; [a] $n = 217$; [b] $n = 226$; [c] $n = 99$; [d] $n = 101$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

PDA, percent days abstinence.

group. The tolerance values in the total sample ranged between 0.580 and 0.976 and in the drinking group, they ranged from 0.497 to 0.972.

Course of Self-Efficacy

There was a significant time x group interaction effect (F [3, 217] = 16.54, $p < 0.001$) over all 4 measurements, indicating that self-efficacy changes differently over time depending on drinking status at 5-year follow-up (abstinent vs. drinking group). The abstinent group shows an increase, while the drinking group shows a decrease in self-efficacy (see mean values and SDs in Table 1 and the online suppl. Fig. 1; for online suppl. material, see www.karger.com/doi/10.1159/000500520).

Simple Mediation Analyses

Two simple mediation models were tested for all 3 outcome variables. Note that the first model included motivation as the mediator and the second model included self-efficacy as the mediator.

Simple Mediation Effects on Abstinence in the Total Sample

In the first model, the total effect of self-efficacy on abstinence at discharge was significant, $b = 0.177$, $SE = 0.033$, $t = 2.666$, $p = 0.008$ (c path), explaining 9.5% of the variance ($R^2 = 0.031$, F [1, 219] = 7.105, $p = 0.008$) in abstinence at 5-year follow-up. The same result applied for the total effect in the second model, as self-efficacy at discharge significantly predicted being abstinent, $b = 0.226$, $SE = 0.066$, $t = 3.5$, $p < 0.001$, explaining 5% of the variance ($R^2 = 0.051$, F [1, 228] = 12.251, $p < 0.001$). The results of the simple mediation models are summarised in Table 2.

The relationship between self-efficacy at discharge and being abstinent at 5-year follow-up was not significantly mediated through motivation at 1-year follow-up but rather through self-efficacy at 1-year follow-up.

Simple Mediation Effects on PDA in the Drinking Group

Self-efficacy at discharge significantly predicted PDA, $b = 0.035$, $SE = 0.017$, $t = 2.019$, $p = 0.046$, $R^2 = 0.109$ (c path), in the first simple regression model. In contrast, the total effect in the second model revealed a trend but fell short of statistical significance, $b = 0.032$, $SE = 0.018$, $t = 1.779$, $p = 0.078$, $R^2 = 0.099$ (c path). As shown in Table 2, self-efficacy at discharge is a predictor of increased motivation and self-efficacy at 1-year follow-up, and the 2 variables were predictive of more PDA. Self-efficacy at discharge on PDA at 5-year follow-up was significantly mediated through its effect on both motivation and self-efficacy at 1-year follow-up.

Simple Mediation Effects on DDD in the Drinking Group

Statistical effects on DDD did not show any significant relationship. There was no significant total effect of self-efficacy at discharge on the DDD in the first model ($b = 0.109$; $SE = 0.366$, $t = 0.298$, $p = 0.767$) nor in the second model ($b = 0.092$; $SE = 0.353$, $t = 0.261$, $p = 0.795$). The same was true for the indirect effects of self-efficacy at discharge on DDD at 5-year follow-up, neither through motivation, $b = –0.419$, Boot $SE = 0.290$, BCa CI (–1.084 to 0.105) nor through self-efficacy at the 1-year follow-up, $b = –0.035$, Boot $SE = 0.221$, BCa CI (–0.501 to 0.397).

Table 3. Model summary for serial multiple mediator analysis of abstinence-related self-efficacy at discharge on 5-year abstinence through 1-year self-efficacy and motivation

	Motivation 1-year (M_1)				Self-efficacy 1-year (M_2)				Abstinence[1] (Y)			
		b	*SE*	*t*		*b*	*SE*	*t*		*b*	*SE*	*z*
Self-efficacy discharge (X)	a_1	1.597	0.251	6.375***	a_2	0.472	0.099	4.784***	c'	0.030	0.104	0.289
Motivation 1-year (M_1)		–	–	–	d_{21}	0.199	0.034	5.931***	b_1	–0.023	0.032	–0.712
Self-efficacy 1-year (M_2)		–	–	–		–	–	–	b_2	0.233	0.071	3.279***
Total R^2			0.283				0.420				0.154[a]	
Total R^2 minus R^2 for covariates			0.233				0.370				0.104[a]	
		F (5, 209) = 14.308; $p < 0.001$				F (6, 208) = 37.906; $p < 0.001$				$-2LL$ = 270.092; $p \leq 0.001$		

Regression models are adjusted for the covariates gender, marital status, employment and abstinence at discharge. a_1 path = path from independent variable to mediator variable 1 at 1-year follow-up; b_1 = path from mediator variable 1 to outcome variable; a_2 path = path from independent variable to mediator variable 2 at 1-year follow-up; b_2 = path from mediator variable 2 to outcome variable; d_{21}= path from mediator 1 variable to mediator 2 variable; c' path = path from independent variable to outcome variable.

[1] logistic regression; [a] explained variance Nagelkerke; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

b, unstandardized regression coefficient; X, predictor; $M_{1/2}$, mediator$_{1/2}$; Y, outcome; R^2, explained variance.

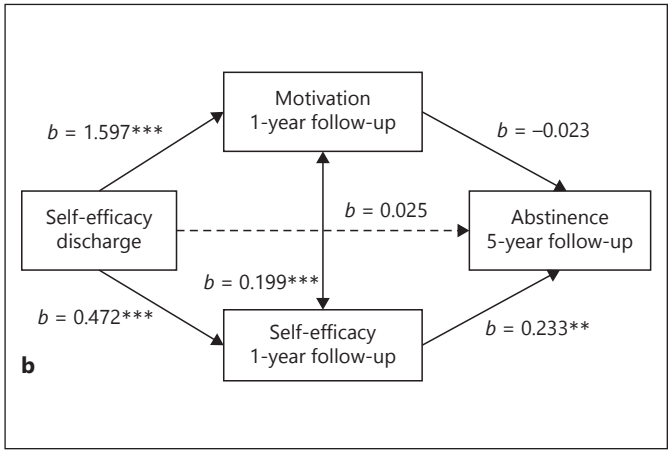

Fig. 2. Serial multiple mediator model through motivation and self-efficacy on abstinence and its significant indirect effects. Indirect pathway b = 0.074, Boost SE = 0.030, 95% BCa CI (0.028–0.144; $a_2d_{21}b_2$); b = 0.110, Boost SE = 0.044, 95% BCa CI (0.037–0.207; a_2b_2). ** $p < 0.01$; *** $p < 0.001$.

Serial Multiple Mediation Analyses

Serial Multiple Mediation Analysis on Abstinence in the Total Sample

The total effect, as depicted in Figure 2, is the direct association of self-efficacy at discharge on abstinence, showing a significant relationship, $b = 0.188$, $SE = 0.032$, $t = 2.813$, $p = 0.005$, $R^2 = 0.035$, $F(1, 217) = 7.914$, $p = 0.005$ (c path). Results from a serial multiple mediation analysis of self-efficacy at discharge on abstinence are presented in Figure 2 and Table 3.

The first indirect effect of perceived self-efficacy at discharge through motivation was not significant, $b = –0.037$, Boot SE = 0.058, 95% BCa CI (–0.162 to 0.059; a_1b_1 path; Fig. 1). The second indirect effect ($a_1d_{21}b_2$ path) is the specific indirect effect of self-efficacy at discharge on abstinence through motivation and self-efficacy at 1-year follow-up with motivation modelled as affecting self-efficacy at 1-year follow-up predicting abstinence. The third significant indirect effect (a_2b_2 path; Fig. 1) is that self-efficacy at discharge predicted abstinence only through self-efficacy at the 1-year follow-up, while all other variables held constant. There was no evidence that self-efficacy at discharge predicted abstinence independently of its effect on motivation and self-efficacy at 1-year follow-up.

Serial Multiple Mediation Analysis on PDA in the Drinking Group

Self-efficacy at discharge significantly predicted PDA, $b = 0.044$, $SE = 0.016$, $t = 2.796$, $p = 0.006$, $R^2 = 0.133$ (c path). The second serial multiple mediation analysis is presented in Table 4.

Motivation did not contribute significantly to the mediation of self-efficacy at discharge on PDA, $b = 0.019$, Boot SE = 0.016, 95% BCa CI (–0.009 to 0.053; a_1b_1 path; Fig. 1), but for abstinence the second indirect path was significant b = 0.020, Boot SE = 0.009, 95% BCa CI (0.006– 0.060; $a_1d_{21}b_1$ path; Fig. 1). Third, self-efficacy at 1-year follow-up independently mediated the relationship between self-efficacy at discharge on PDA, $b = 0.013$, Boot SE = 0.007, 95% BCa CI (0.002–0.032; a_2b_2 path; Fig. 1). Again, self-efficacy at discharge was unrelated to PDA, when both mediator variables, motivation and self-efficacy, at 1-year follow-up were included.

Table 4. Model summary for serial multiple mediator analysis of self-efficacy at discharge on 5-year PDA through 1-year self-efficacy and motivation

	Motivation 1-year (M_1)				Self-efficacy 1-year (M_2)				PDA (Y)			
		b	*SE*	*t*		*b*	*SE*	*t*		*b*	*SE*	*t*
Self-efficacy discharge (X)	a_1	1.879	0.313	5.995***	a_2	0.259	0.130	1.994*	c'	–0.003	0.021	–0.165
Motivation 1-year (M_1)		–	–	–	d_{21}	0.219	0.045	4.858***	b_1	0.010	0.008	1.259
Self-efficacy 1-year (M_2)		–	–	–		–	–	–	b_2	0.049	0.016	3.090**
Total R^2			0.400				0.395				0.313	
Total R^2 minus R^2 for covariates			0.350				0.345				0.263	
		F (4, 93) = 10.561; $p < 0.001$				F (5, 92) = 25.038; $p < 0.001$				F (6, 91) = 10.118; $p \leq 0.001$		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Regression models are adjusted for the covariates gender, marital status and employment; a_1 path = path from independent variable to mediator variable 1 at the 1-year follow-up; b_1 = path from mediator variable 1 to outcome variable; a_2 path = path from independent variable to mediator variable 2 at the 1-year follow-up; b_2 = path from mediator variable 2 to outcome variable; d_{21} = path from mediator 1 variable to mediator 2 variable; c' path = path from independent variable to outcome variable.

b, unstandardized regression coefficient.

X, predictor; $M_{1/2,}$ $mediator_{1/2}$; Y, outcome; R^2, explained variance; PDA, percent days abstinence.

Serial Multiple Mediation Analysis on DDD in the Drinking Group

As seen in the simple mediation analyses on DDD, the third model of the serial multiple mediation remained non-significant. None of the indirect effects were significant: The first indirect effect through motivation, $b = -0.465$, Boot $SE = 0.392$, BCa CI (–1.266, 0.236; a_1b_1 path; Fig. 1); the second indirect effect through motivation and self-efficacy, $b = 0.055$, Boot $SE = 0.155$, 95% BCa CI (–0.232 to 0.406; $a_1d_{21}b_2$ path; Fig. 1); and the third indirect effect of self-efficacy at discharge on DDD through self-efficacy at 1-year follow-up, $b = 0.035$, Boot $SE = 0.104$, 95% BCa CI (–0.128 to 0.313; a_2b_2 path; Fig. 1).

Discussion

This study employed simple and serial multiple mediation analyses to explore the effect and predictive value of self-efficacy at discharge via self-efficacy and motivation at 1-year follow-up on long-term drinking outcomes (i.e., abstinence, PDA and DDD at 5-year follow-up). These results extend previous findings, which predicted drinking outcomes up to 1-year post-treatment [14–16].

Few studies in the field of AUD research were able to show evidence that post-treatment self-efficacy may mediate treatment outcome at discharge to long-term outcome [10, 11]. The purpose of this study was to elucidate what occurs after AUD treatment if the patients feel confident enough to remain abstinent for the year thereafter and how their confidence may affect long-term drinking behaviour. There was one main finding indicating a reciprocal association between self-efficacy and the motivation to make active changes in one's behaviour. Patients with higher self-efficacy at discharge may have a sense of mastery as a result of experiencing increased success during treatment, which in turn may motivate and reinforce behavioural changes and positively affect consumption patterns. If patients continue being successful in managing their drinking behaviour or even remain abstinent post-treatment, this could further strengthen patients' self-efficacy and motivation to maintain abstinence or drink on fewer days than before residential treatment, eventually possibly leading to better long-term drinking outcomes. This was most notably apparent for the course of self-efficacy from the beginning of the residential treatment until 5-year follow-up if patients had remained abstinent over a long time. The same association is also suggested by the results of the mediation analysis with regard to the frequency of drinking days (i.e., increase in self-efficacy is related to increase in PDA), but not with regard to the quantity when drinking occurred (i.e., no association between self-efficacy and DDD). These results are similar to previous findings on smoking cessation, suggesting that taking active steps toward altering behaviour is insufficient to stop smoking, but that affirming self-efficacy is also needed to implement long-term behavioural change [38].

Self-efficacy at 1-year follow-up was shown to mediate the relationship of self-efficacy at discharge on drinking frequency in all mediation models, meaning that higher self-efficacy at discharge predicted higher self-efficacy at 1-year follow-up, which in turn predicted abstinence and higher PDA at 5-year follow-up. These findings indicate that self-efficacy may play an important role in long-term

abstinence as well as in PDA. Returning to the context of smoking cessation, a previous study by Cupertino et al. [39] found similar results; in particular, higher self-efficacy at baseline predicted higher self-efficacy at 6 months, which in turn predicted complete cessation at 12 months. A primary strategy in AUD treatment, such as motivational interviewing [19] or motivational enhancement therapy [40], is to improve the motivation to change behaviour by enhancing self-efficacy during treatment, and thus to prevent relapse [41]. We carefully assume that higher self-efficacy may lead to greater perseverance when attempting to abstain from alcohol. In turn, prolonged abstinence may increase self-efficacy as the course of self-efficacy in our sample suggests (online suppl. Material).

These results are also consistent with research in the TTM field and provide empirical support, namely, that cognitive characteristics, such as self-efficacy, and behavioural features, such as motivation, seem to be required to modify drinking patterns, that is, to attain a better drinking outcome [5]. TTM is the theoretical foundation of the SOCRATES, but empirical studies do not always support the 5 stages of change, thereby challenging this model [42, 43]. When evaluating motivation to change, West [43] recommends reverting to simple questions about what one does for change, such as those which comprise the taking steps subscale used in this study.

Contrary to drinking frequency, the predictive value of self-efficacy at discharge on drinking quantity in DDD at 5-year follow-up failed to be confirmed by simple mediation and serial multiple mediation analyses. This seems to be consistent with patients' perspective, as the inquiry referred to one's confidence related to staying abstinent during the year after treatment. Other variables, such as controlled drinking as a treatment goal or a person's social environment, may influence DDD more than self-efficacy or the motivation to abstain from drinking. Nowadays, decreasing the amount of alcohol consumed in order to reduce heavy drinking (rather than insisting on abstinence) has increasingly become recognised as a treatment goal, although only a few treatment programs for controlled drinking and harm reduction exist [44]. In contrast to our findings, however, Levin et al. [17] found that the single-item also predicted levels of alcohol use at 5-year follow-up.

Our results are especially relevant concerning post-treatment effects, since relapses occur more often when action is not taken [45]. Enhancing self-efficacy, such that patients commit to reducing their alcohol use, may foster their actual behavioural changes. Despite the remaining likelihood of a relapse occurring after treatment, boosting self-efficacy could possibly be a crucial component in any kind of AUD treatment. However, questions regarding the actions or skills patients are willing to take to alter their drinking behaviour still remain diverse and are greatly individualized. Hence, future research should focus more closely on these questions. Furthermore, as noted by Hoeppner et al. [14] in the clinical context, it may be useful to examine self-efficacy and motivation with regard to specific scenarios and contexts, for example, individual patient-centered high-risk situations or the positive and negative effects of specific social situations.

These findings should be interpreted with caution due to some limitations. First, the data on drinking behaviour were collected retrospectively at each time point for the 3 months prior to measurement and may be biased due to self-report issues, such as social desirability, recall bias or error of central tendency. Nevertheless, self-report methods, which are pragmatic for respondents, relatively inexpensive and non-invasive, constitute a reliable and valid approach to measure alcohol consumption [46]. Data in future studies should also be gathered through external assessments by family members, friends, ecological momentary assessment or biochemical markers. Second, both mediation variables, self-efficacy and motivation, were collected simultaneously at 1-year follow-up. Thus, it is not possible to properly assess the causal relationship of these two concepts. Further research should employ more longitudinal post-treatment designs and frequently collect data in order to provide a more specific overview of temporal changes in self-efficacy and motivation. Third, the 4-year period of time between the 1- and 5-year follow-up assessments following treatment was somewhat long. Various factors, such as outpatient treatment, inpatient treatment after a severe relapse, life crisis, health problems and social environment, might have had an impact on the mediator and outcome variables. Fourth, the motivation to change was not assessed at discharge for theoretical reasons (see subchapter measures), preventing the examination of how committed the patients were to further change their drinking behaviour directly after the treatment. Fifth, some statistical limitations should be considered as well: Although VIF and tolerance statistics were acceptable, it was apparent that emerging multicollinearity in the regression models caused b values to run a small risk of becoming unreliable, and thus, the explained variance (R^2) might have been slightly overestimated [34, 47]. Estimates of mediation analyses might be biased because the SPSS PROCESS's

list wise deletion method related to covariates is not fully robust to the missing at random assumption. The distributions of the outcome variable DDD and PDA in the drinking group are skewed and flat, respectively, and thus not normal, which might have influenced the regression analyses. Lastly, in the subgroup analyses, the statistical power is reduced by the smaller sample sizes, so that only medium and large effects of mediators can be expected. Sixth, the results may not be generalisable to patients with SUDs other than alcohol, to those with less severe AUD or to patients attending outpatient AUD treatments of different durations and/or treatment orientations. Finally, the direct causality of the relationship between self-efficacy, motivation of change and drinking outcomes cannot be established since self-efficacy and motivation were not experimentally controlled. However, the study provides a better understanding of the approximation of the potential associations among the intrapersonal constructs, and our findings could be tested in a randomised control trial. The strengths of this study were a naturalistic longitudinal design with a considerable sample size, with only a few differences in covariates between completers and dropouts yielded at 5-year follow-up.

Conclusions

The current study sheds light on the importance of the self-defined, single-item measure of abstinence-related self-efficacy as a relevant predictor of future long-term drinking frequency. Patients with higher confidence in their ability to remain abstinent after residential AUD treatment exhibited more motivation and had changed their drinking patterns at 1-year follow-up, which in turn was associated with abstinence and more PDA at the 5-year follow-up. The results indicate that motivation to change and self-efficacy are interrelated in potentially improving long-term drinking behaviour. These two intrapersonal resources may be crucial mechanisms in treating AUD. Future research and clinicians providing AUD treatment should focus on how to further increase abstinence-related self-efficacy and action-oriented motivation in patients with severe AUD.

Acknowledgements

We would like to thank all patients and staff members of the 12 residential treatment programs who took part in this study and Hallie M. Batschelet for editorial assistance.

Statement of Ethics

Subjects have given their written informed consent. The study protocol has been approved by the Ethics Committee of the Canton of Bern, Switzerland (Proposal-Nr: 109/99).

Disclosure Statement

The authors have no conflicts of interest to declare.

Funding Sources

This research project was financially supported by the Swiss National Science Foundation (SNF Grant No.: 32-58803.99). The funding source was not involved in study design; in the collection, analysis and interpretation of data; in the writing of the report and in the decision to submit the article for publication.

Author Contributions

F.M.: was the principal investigator who wrote the study protocol, received the SNF Grant and coordinated the project. He was also involved in the data collection, management and analyses. A.M.: analysed the data and wrote the first draft of the manuscript. A.M., H.Z., and F.M.: contributed to the interpretation of the data, commented on various versions of this manuscript and approved the final version.

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